POTATO TUBER BULKING RATE AND PROCESSING QUALITY FOR EARLY HARVEST

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Introduction

The six potato varieties 'Alturas', 'Ranger Russet', 'Russet Burbank', 'Shepody', 'Umatilla Russet', 'Wallowa Russet', and the five numbered clones, 'A9014-2', 'A9045-7', 'A90586-11', 'A92294-6', and 'A93157-6LS' were compared for tuber yield, size distribution, and processing quality at six harvest dates. Russet Burbank, Shepody and Ranger are currently grown in the Treasure Valley for processing and served as the check varieties. Umatilla and Wallowa Russet are new releases from Oregon State University (OSU) that have demonstrated yield, grade, and processing quality superior to Russet Burbank, Shepody, and Ranger Russet in some trials. The numbered clones have performed well at Ontario in previous variety trials, including the Western Regional Early Harvest Trial, over several years. The first objective of this study was to test potato cultivars that are currently available, and some numbered clones that may soon be released, for very early harvest, compared to the varieties currently grown for early harvest for processing. The second objective was to determine if any of these clones would continue to bulk tubers late in the season.

Materials and Methods

The soil was Owyhee silt loam where winter wheat was the previous crop. The wheat stubble was flailed and the field was irrigated and disked. A soil test taken September 9, 2002 showed 18 ppm NO_3, 18 ppm P, 306 ppm K, organic matter 2.2 percent, and pH 7.6. Fall fertilizer consisting of 21 lb N/acre, 100 lb P_2O_5/acre, 60 lb K_2O/acre, 60 lb S/acre, 30 lb Mg/acre, 4 lb Zn/acre, 2 lb Cu/acre, 1 lb Mn/acre, and 1 lb B/acre was broadcast. The field was ripped, Telone II was injected at 25 gal/acre, and the field was bedded on 36-inch row spacing.

The experiment had a split-plot design, with the six harvest dates as the main plots replicated four times and with varieties randomized as sub-plots within each main plot. This was accomplished by planting the rows so that each harvest date pass through each replicate would include all of the varieties.

Potato seed was obtained from the OSU Potato Variety Development program at Powell Butte, and placed into storage at 42°F. Seed of the cultivar Ranger Russet was donated by J.R. Simplot Co., Caldwell, ID, from commercial certified seed produced in eastern Idaho. Seed tubers were cut by hand into approximately 2 oz pieces, treated

with Tops MZ + Gaucho seed treating dust, and counted into bags of 15 seed pieces for each row of the two-row plots.

The potato clones were planted on April 10 with rows spaced 36 inches apart and 9-inch spacing between seed pieces in the row. The soil condition was excellent, with good tilth and good soil moisture. The soil temperature at the 10-inch seed piece depth was almost 50°F.

A two-row per bed configuration was maintained at planting by leaving off the center furrowing shovel of the two-row planter. On May 5, the beds were formed with a spike harrow with wide shovels that also carried the shank to install a drip tape at 3-inch depth in the top of the bed between the two potato rows. Drip tape was 5/8-inch diameter, 5-mil wall thickness, 12-inch emitter spacing, 0.22-gpm/100 ft flow rate (T-tape, T Systems International, San Diego, CA).

Soil water potential was measured with six Watermark sensors (Irrometer Corp., Riverside, CA) installed in the potato row at the seedpiece depth and connected to an AM400 datalogger (M.K. Hansen, East Wenatchee, WA). Water potential readings were recorded manually from the data logger. Irrigations were scheduled to replace evapotranspiration (Et) estimated by an automated AgriMet (U.S. Bureau of Reclamation, Boise, ID) station located less than 0.25 mile away on the Malheur Experiment Station.

Prowl at 1 lb/acre plus Dual at 2 lb/acre was applied on May 1, before any potato plants had emerged, and was incorporated by a total of 0.42 inch of rain May 3 through 5. Matrix herbicide was applied at 1.25 oz/acre on May 28, and was incorporated by 0.57 inch of rain during subsequent days. Vydate insecticide/nematicide was injected through the drip tape in the first irrigation on June 6 at a rate of 2 pints/acre. During Vydate injection, the irrigation water was acidified to approximately pH 5 by injecting dilute sulfuric acid into the mainline upstream of the Vydate injection.

Fungicide applications to protect the potato foliage from early blight and potential late blight infection started with an aerial application of Ridomil Gold and Bravo at 1.5 pint/acre on June 7, which was repeated on June 25. Bravo fungicide plus liquid sulfur was applied by aerial applicator on July 2, and again on August 8. Sulfur dust was applied by aerial applicator on July 20 at 40 lb S/acre to prevent mite infestation and powdery mildew infection.

Petiole tests were taken every 2 weeks from June 12, and fertilizer was injected into the drip system during irrigation to supply nutrient needs (Table 1). Fertilizer was applied by fertilizer injection into the drip irrigation system only in response to petiole tests.

Tuber initiation was noted on several plants on June 3. On June 19, the first tubers were dug from one row in each replicate. Tubers were sorted by weight and counted. On July 10, tubers were harvested from each replicate, and graded by the U.S. No. 1 and No. 2 processing standard, sorted by weight, and counted in each weight category.

Marketable yield for processing was defined as all of the U.S. No. 1 and No. 2 tubers larger than 4 oz. Specific gravity and length-to-width ratio were measured using a sample of 10 tubers. Fry color was determined from a 20 tuber sample from each plot. The subsequent harvests, on July 31, August 21, September 11, and October 2, followed the same procedure as the second harvest.

Yield and quality results data were compared using analysis of variance (Number Cruncher Statistical Systems, Kaysville, UT). Tuber development over time was evaluated using regression of the ratio of polynomials equation:

$y = (a+bx+cx^2) / (1+dx+ex^2)$, where y is the yield and x is days after planting (DAP).

Results and Discussion

The 2003 growing season was marked by record heat, with 110°F recorded on July 20, and prolonged heat throughout the summer. Irrigation plus rain supplied 29.7 inches of water, or 94.2 percent of AgriMet Et, which totaled 31.5 inches through the growing season (Fig. 1). The early season moisture deficit indicated that more water should have been applied early in the season to more closely match Et (Fig. 2) starting at 31 DAP. Excessively dry readings may have been partially due to sensor placement.

Potato clones varied in yield and tuber size distribution at the last three harvest dates (Table 2). Umatilla Russet was among the heavier bulking clones when harvested 132 DAP. Marketable yields for Umatilla Russet showed the earliest bulking potential at 132 DAP with 513 cwt/acre, compared to Russet Burbank and Shepody with 473 and 425 cwt/acre, respectively. The percent U.S. No. 1 yields were 87, 59, and 69 percent, respectively. Russet Burbank also had a sugar end incidence of 37.5 percent, the highest of any clone at this harvest date.

Growers can only plant varieties that have seed available and that have been accepted by processing companies for contract production. At present, seed is available for Umatilla Russet, Shepody, and Ranger Russet. When the bulking rate of Umatilla Russet, Shepody, and Ranger Russet are compared over the last three harvest dates, Umatilla Russet tended to have a yield advantage. Other clones, such as A92294-6 and A93157-6LS, were also promising (Table 2).

Tubers in the larger than 12 oz size category are too big for optimum production of frozen french fries. Because 6-10 oz tubers are considered ideal for processing, the yield of that size category was graphed over time, along with total yield and marketable yield for each potato clone (Figs. 2-14).

In previous work Shock et al. (2003) showed that a major factor limiting potato productivity in Malheur County is the failure of tubers to continue to bulk late in the growing season. In the current work, most varieties and experimental clones failed to have substantial marketable yield increases after 153 DAP (Figs. 3-5, 8-13). This lack of increase in marketable yield after 153 DAP was noted for Ranger Russet, Russet

Burbank, Shepody, and Umatilla Russet (Figs. 9-12). In contrast, A92294-6 and A93157-6LS continued their upward trends in marketable yield to 174 DAP (Figs. 6 and 7), finishing with 689 and 658 cwt/acre, respectively. These clones deserve special attention in future trials and possible tests for resistance to early death through heat stress and the component pathogens of the "early die" syndrome (Fig. 14).

The average date of last frost at Malheur Experiment Station is April 29. In this trial planted on April 10, 2003, an overnight low of 32°F occurred on the night of May 19, but no frost injury was observed. Any early harvest yield advantage of early planting dates has to be weighed in relation to the risk of frost damage.

Although Shepody is widely used as an early harvest variety, it is not especially suited as an early harvest variety. Many other clones included in this trial bulked fairly early (Figs. 3-5, and 14) compared to Shepody. Of these, A90586-11 has shown resistance to late blight in addition to having good yield and processing quality. From the Western Regional Early Potato Variety Trials in Ontario over the past few years several additional new clones have shown promise for early harvest (data not shown).

References

Shock, C.C., E.P. Eldredge, and L.D. Saunders. 2003. Tuber bulking rate of processing potato clones in relation to planting date. Oregon State University Agricultural Experiment Station, Special Report 1048:152-158.

Table 1. Fertilizer applied to potato clones and varieties grown under drip irrigation, Malheur Experiment Station, Oregon State University, Ontario, OR, 2003.

Date	NO_3	P_2O_5	K_2O	SO_4	S	Fe	Mg	Mn	Zn	Cu	B
	lb/acre										
6/19	28.5							0.36		0.23	
7/1	20.0	6.0		1.3			0.5	0.25	0.25	0.25	
7/17	20.0			43.0				0.25	0.25		
7/19					40.0						
7/28	3.2	10.0	1.1						0.09		
8/5	16.0	11.4	11.4	10.0		0.57		0.28	0.23	0.28	0.01
8/14	20.0							0.25		0.20	
total	107.7	27.4	12.5	54.3	40.0	0.57	0.5	1.39	0.82	0.96	0.01

Table 2. Tuber yield, grade, length-to-width ratio, specific gravity, and fry color of five potato clones and six potato varieties that grew until vine removal on August 20, September 5, or October 1. Malheur Experiment Station, Oregon State University, Ontario, OR, 2003.

		Days after planting	Total yield	U.S. No.1 Yield	U.S. No.1 Percent	Marketable yield Total	Marketable yield 6-10oz	Tubers <4 oz	Length /width	Specific gravity	Fry color light reflectance stem	Fry color light reflectance bud	Fry color light reflectance avg.	Sugar ends
Cultivar/clone	Hrv	DAP	-cwt/acre-		%	-------cwt/acre--------			ratio	gcm^{-3}	----------%----------			
A9014-2	8/20	132	496	469	98	481	146	15	1.60	1.085	57	59	58	0.0
	9/5	153	545	507	96	528	143	17	1.64	1.086	58	58	58	0.0
	10/1	174	567	539	98	553	97	14	1.71	1.082	55	57	56	1.3
A9045-7	8/20	132	514	435	89	489	184	24	1.62	1.089	45	42	43	0.0
	9/5	153	538	425	83	504	152	34	1.70	1.088	40	43	41	3.8
	10/1	174	624	513	87	586	137	38	1.68	1.086	39	42	40	5.0
A90586-11	8/20	132	483	353	80	441	183	42	1.83	1.086	48	44	46	1.3
	9/5	153	505	329	71	464	160	41	1.87	1.090	37	46	42	5.0
	10/1	174	596	363	66	557	170	39	1.84	1.090	35	44	40	12.5
A92294-6	8/20	132	535	438	89	492	268	43	2.07	1.092	55	52	54	0.0
	9/5	153	643	431	72	605	233	38	2.06	1.089	45	56	51	2.5
	10/1	174	728	556	80	689	269	39	2.08	1.089	46	56	50	1.3
A93157-6LS	8/20	132	483	423	94	451	192	32	1.81	1.085	47	39	43	13.8
	9/5	153	561	470	91	516	174	45	1.89	1.092	44	47	46	13.8
	10/1	174	694	575	87	658	154	36	1.89	1.088	38	45	42	5.0
Alturas	8/20	132	456	341	91	375	181	81	1.47	1.081	57	57	57	0.0
	9/5	153	574	447	91	490	222	84	1.47	1.081	57	56	57	0.0
	10/1	174	641	503	93	544	220	97	1.49	1.080	55	56	55	1.3
Ranger R.	8/20	132	474	370	82	454	141	19	1.95	1.090	49	43	46	0.0
	9/5	153	532	367	72	516	110	16	1.99	1.092	45	49	47	0.0
	10/1	174	563	353	66	532	115	31	2.02	1.090	42	47	45	0.0
R. Burbank	8/20	132	515	279	59	473	209	43	2.10	1.077	48	29	39	37.5
	9/5	153	544	274	56	485	188	59	2.05	1.075	25	45	35	28.8
	10/1	174	582	239	44	521	177	62	2.10	1.071	26	43	35	37.5
Shepody	8/20	132	442	289	69	425	108	17	1.67	1.080	52	45	49	0.0
	9/5	153	474	247	55	458	110	17	1.73	1.081	46	51	49	1.3
	10/1	174	473	264	58	455	103	18	1.63	1.080	46	50	48	0.0
Umatilla R.	8/20	132	551	448	87	513	212	38	1.86	1.083	50	37	43	10.0
	9/5	153	600	406	77	532	222	68	1.86	1.086	48	49	48	0.0
	10/1	174	628	437	77	566	205	61	1.91	1.081	43	48	45	1.3
Wallowa R.	8/20	132	520	420	88	480	218	40	1.88	1.088	49	39	44	3.8
	9/5	153	517	373	78	471	198	45	1.84	1.087	40	47	44	1.3
	10/1	174	631	450	77	578	207	53	1.86	1.083	39	44	42	5.0
Mean	8/20	132	497	388	84	461	186	36	1.80	1.081	51	44	47	6.0
	9/5	153	548	389	76	506	174	42	1.83	1.086	44	50	47	5.1
	10/1	174	612	436	76	567	169	44	1.84	1.084	42	48	45	6.4
LSD (0.05)	Harvest		20	24	4	21	12	6	0.08	0.002	1	1	1	4.8
	Cultivar		25	30	4	26	16	8	0.10	0.002	1	2	1	6.0
	Hrv x Cltvr		61	72	11	63	38	20	0.23	0.005	3	4	3	14.7

Table 3. Tuber grade and size distribution of five potato clones and six potato varieties that grew until vine removal on August 20, September 5, or October 1, Malheur Experiment Station, Oregon State University, Ontario, OR, 2002.

			U.S. No. 1, oz sizes						U.S. No. 2, oz sizes					
			4-6	6-8	8-10	10-12	12-16	>16	4-6	6-8	8-10	10-12	12-16	>16
Cultivar, clone	Harv	DAP	cwt/acre											
A9014-2	8/20	132	32	56	85	99	196	0	1	2	3	3	4	0
	9/5	153	42	45	89	71	103	158	1	5	5	4	4	4
	10/1	174	24	52	44	68	104	247	1	1	0	1	4	6
A9045-7	8/20	132	46	58	110	63	158	0	5	6	10	7	28	0
	9/5	153	50	65	73	78	94	65	10	4	10	7	12	37
	10/1	174	50	58	65	82	111	147	5	4	10	11	15	29
A90586-11	8/20	132	68	63	94	36	94	0	7	9	19	9	44	0
	9/5	153	55	55	61	39	58	62	14	21	24	26	27	23
	10/1	174	57	70	46	75	56	61	14	20	35	47	33	46
A92294-6	8/20	132	78	111	132	60	59	0	9	14	12	7	12	0
	9/5	153	69	103	77	86	64	32	19	25	29	37	41	25
	10/1	174	72	110	115	89	99	72	9	20	24	26	32	23
A93157-6LS	8/20	132	44	51	127	86	116	0	1	7	7	5	9	0
	9/5	153	46	68	93	69	88	107	4	7	7	13	0	15
	10/1	174	41	62	77	83	125	188	2	9	7	13	17	37
Alturas	8/20	132	108	82	84	35	34	0	8	11	5	3	7	0
	9/5	153	129	128	75	62	42	10	11	13	5	4	8	2
	10/1	174	118	118	87	89	59	32	10	8	7	6	9	2
Ranger R.	8/20	132	29	38	73	51	180	0	4	9	22	14	37	0
	9/5	153	22	36	46	44	82	137	5	8	20	29	29	58
	10/1	174	26	38	51	58	63	118	6	13	13	22	37	87
R. Burbank	8/20	132	49	51	87	38	54	0	21	30	41	27	76	0
	9/5	153	55	68	46	46	36	24	23	35	40	39	34	41
	10/1	174	47	53	44	36	32	27	30	34	47	54	53	64
Shepody	8/20	132	34	41	43	33	138	0	9	9	15	19	86	0
	9/5	153	29	31	44	26	52	66	4	17	18	32	53	86
	10/1	174	26	33	43	30	61	72	5	13	15	38	47	73
Umatilla R.	8/20	132	70	87	105	55	131	0	4	10	11	11	30	0
	9/5	153	88	83	103	55	55	24	17	16	20	20	15	38
	10/1	174	86	98	61	74	61	57	14	29	17	29	22	20
Wallowa R.	8/20	132	73	87	105	56	100	0	6	11	16	6	22	0
	9/5	153	76	94	68	57	46	32	9	19	18	19	23	11
	10/1	174	73	85	72	83	68	70	10	27	23	31	26	12
Mean	8/20	132	57	66	95	55	115	0	7	11	15	10	32	0
	9/5	153	60	70	71	58	65	65	11	15	18	21	22	31
	10/1	174	56	71	64	69	76	99	10	16	18	25	27	36
LSD (0.05)	Harvest		7	8	9	9	12	15	3	4	5	5	9	9
	Cultivar		9	10	11	11	16	19	4	5	6	6	11	11
	Hrv x Cltvr		22	25	28	28	38	45	9	12	14	15	26	26

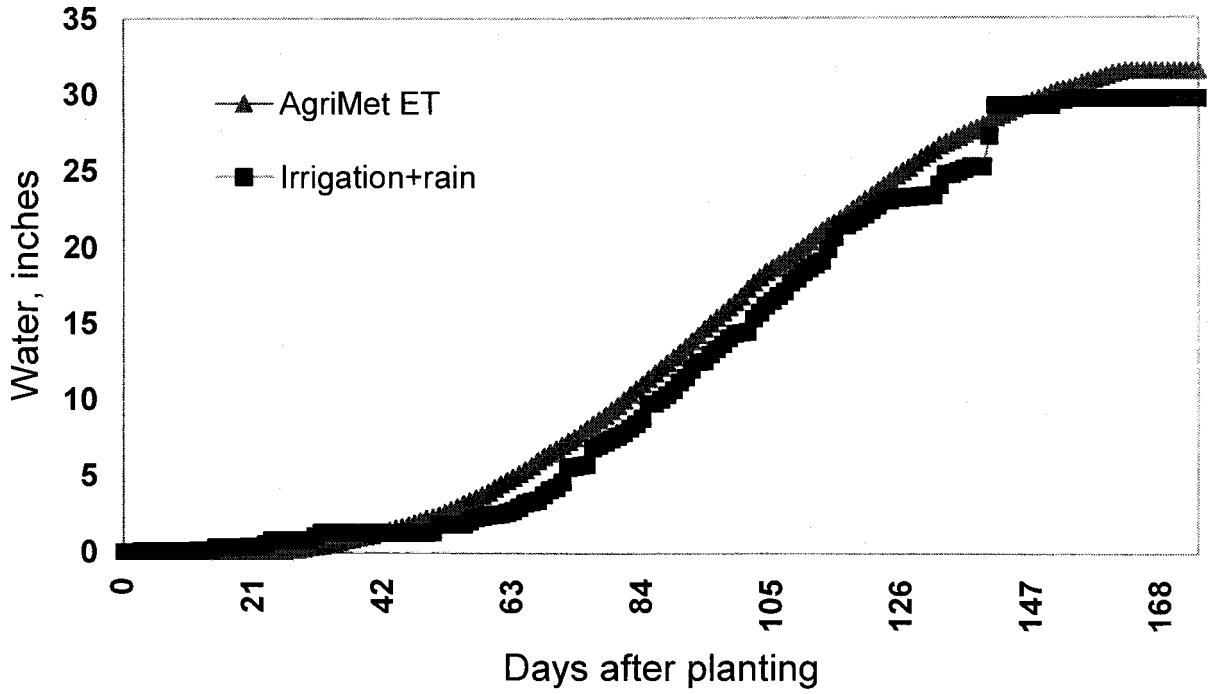

Figure 1. Irrigation water applied through the growing season compared to evapotranspiration (ET) estimated by an AgriMet weather station, Oregon State University, Malheur Experiment Station, Ontario, OR, 2003.

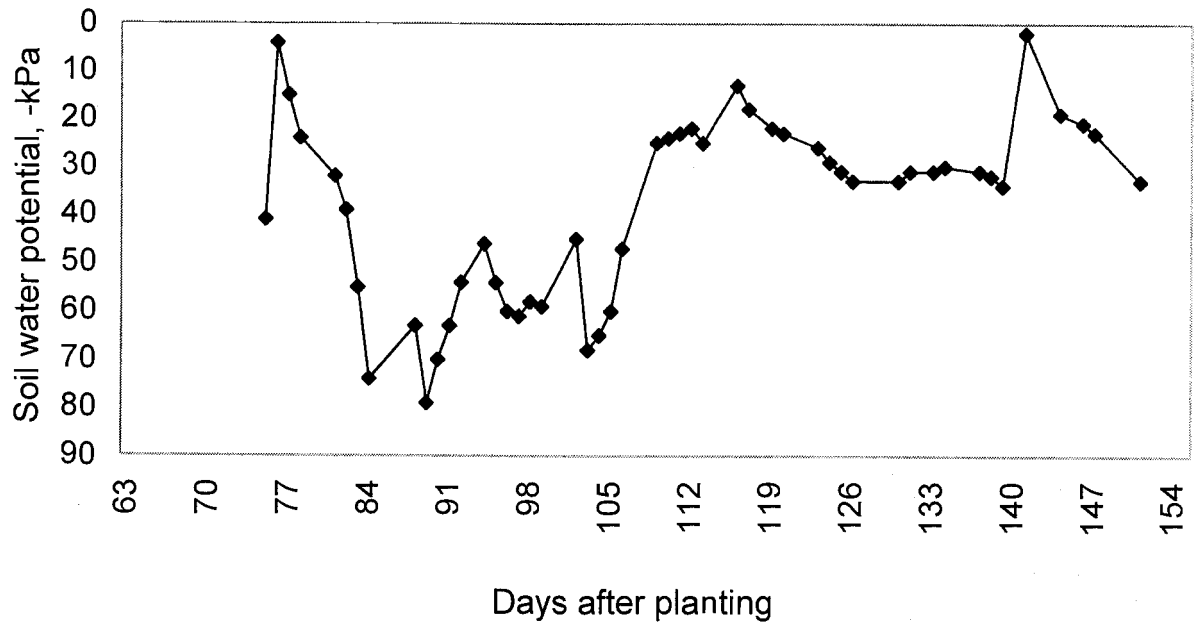

Figure 2. Soil water potential measured by Watermark sensors during the irrigation period of drip-irrigated potato clones, Oregon State University, Malheur Experiment Station, Ontario, OR, 2003.

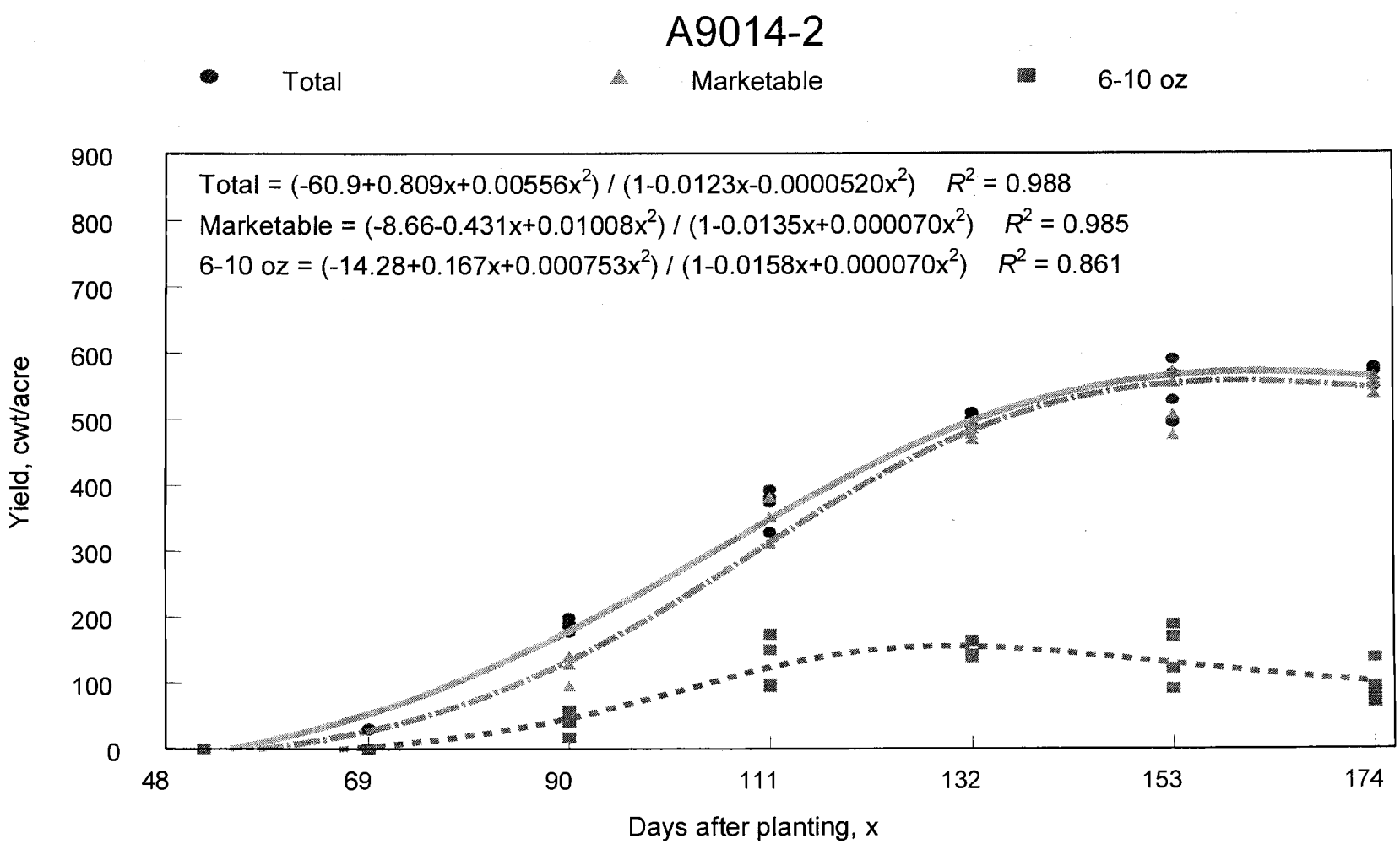

Figure 3. Tuber bulking over time for the clone A9014-2, Oregon State University Malheur Experiment Station, Ontario, OR, 2003.

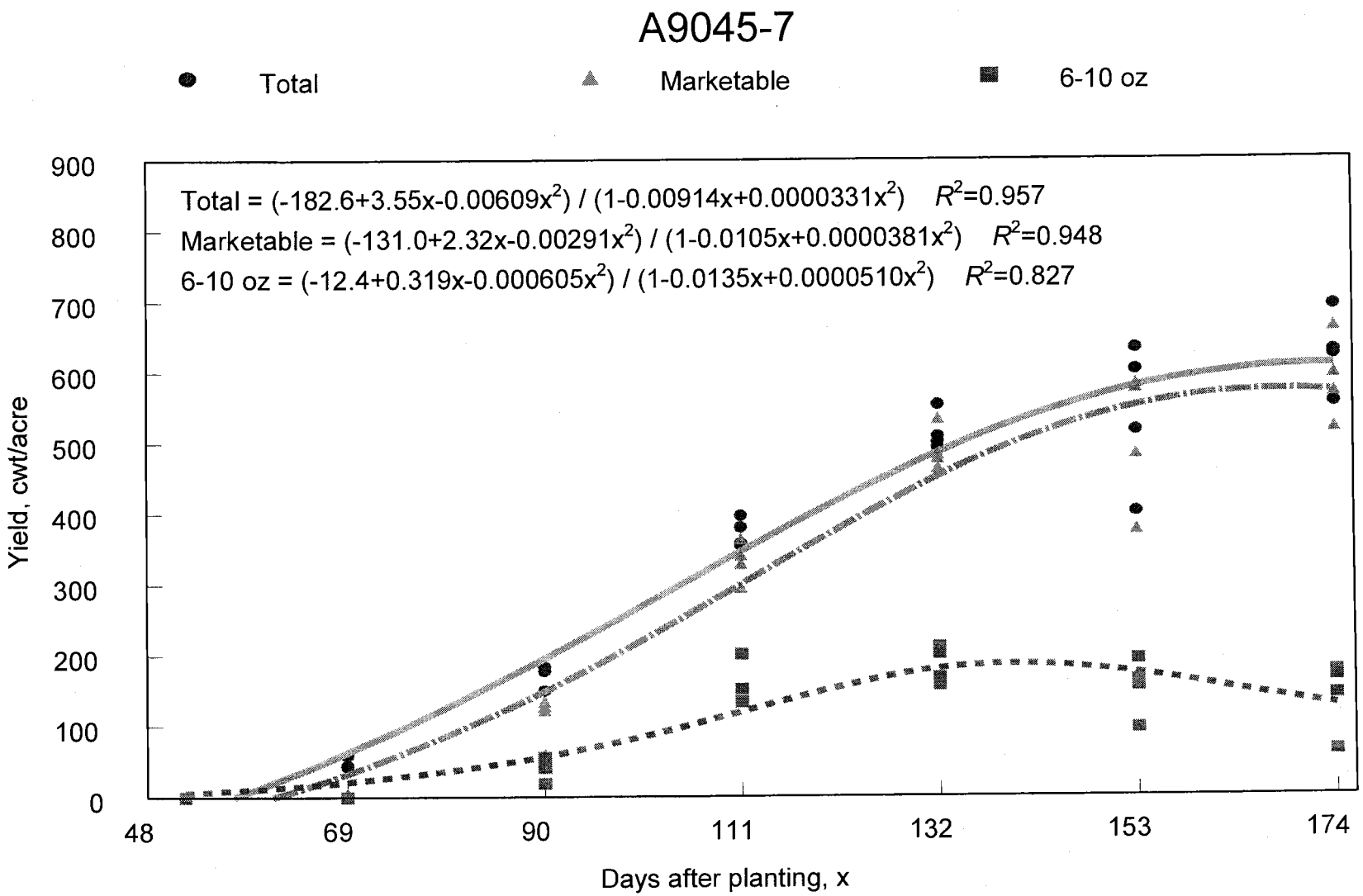

Figure 4. Tuber bulking over time for the clone A9045-7, Oregon State University Malheur Experiment Station, Ontario, OR, 2003.

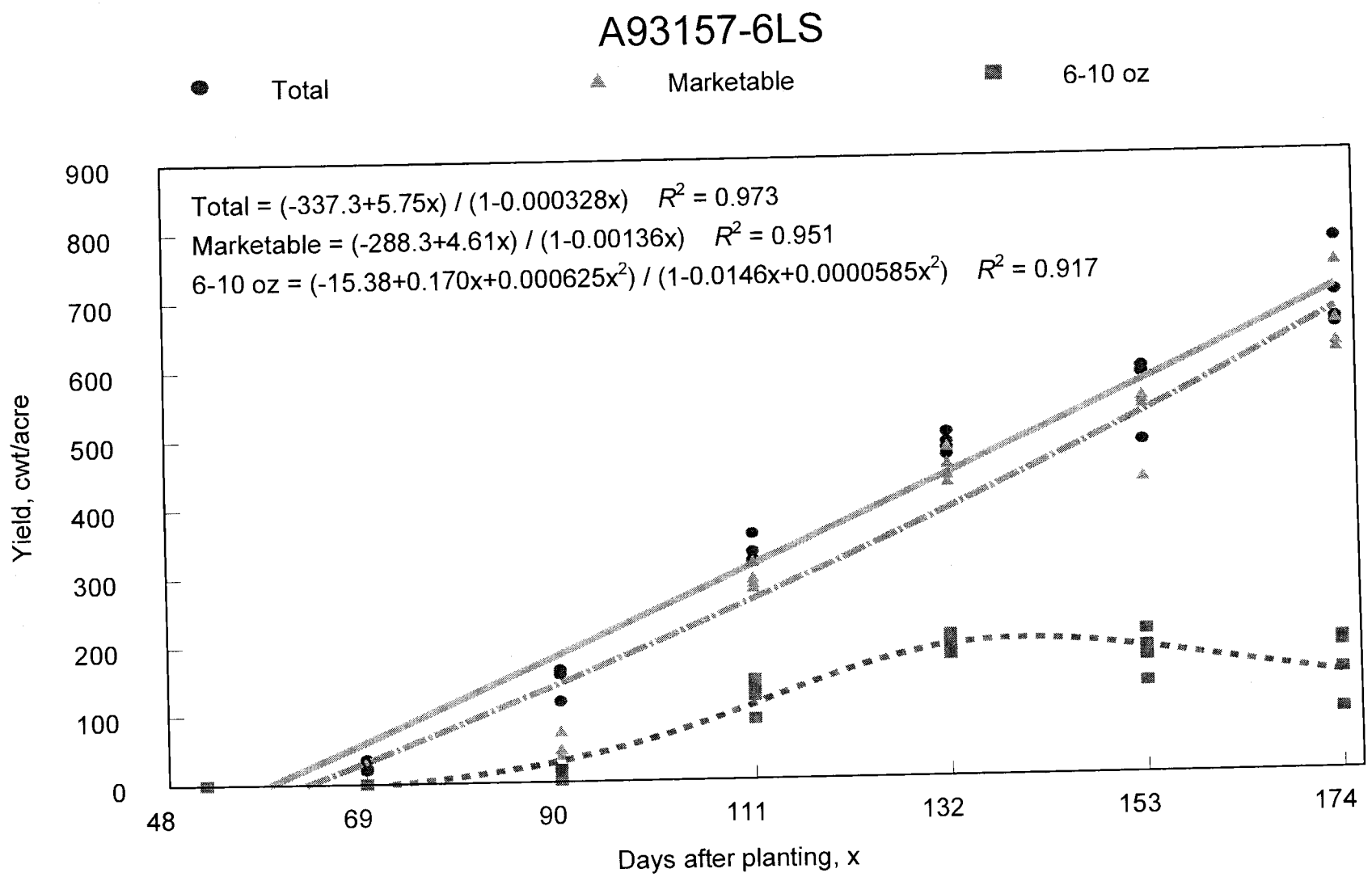

Figure 7. Tuber bulking over time for the clone A93157-6LS, Oregon State University Malheur Experiment Station, Ontario, OR, 2003.

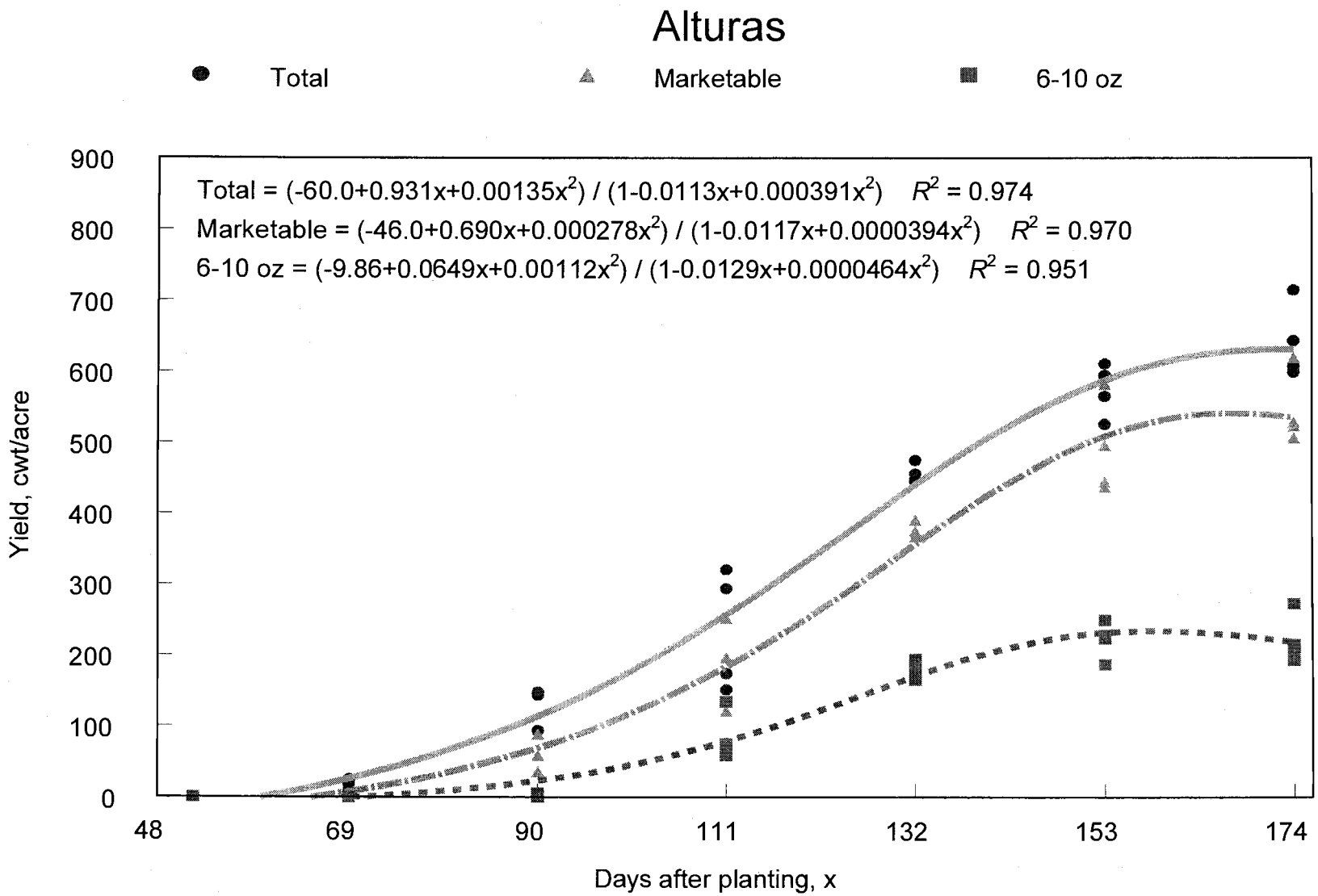

Figure 8. Tuber bulking over time for the cultivar Alturas, Oregon State University Malheur Experiment Station, Ontario, OR, 2003.

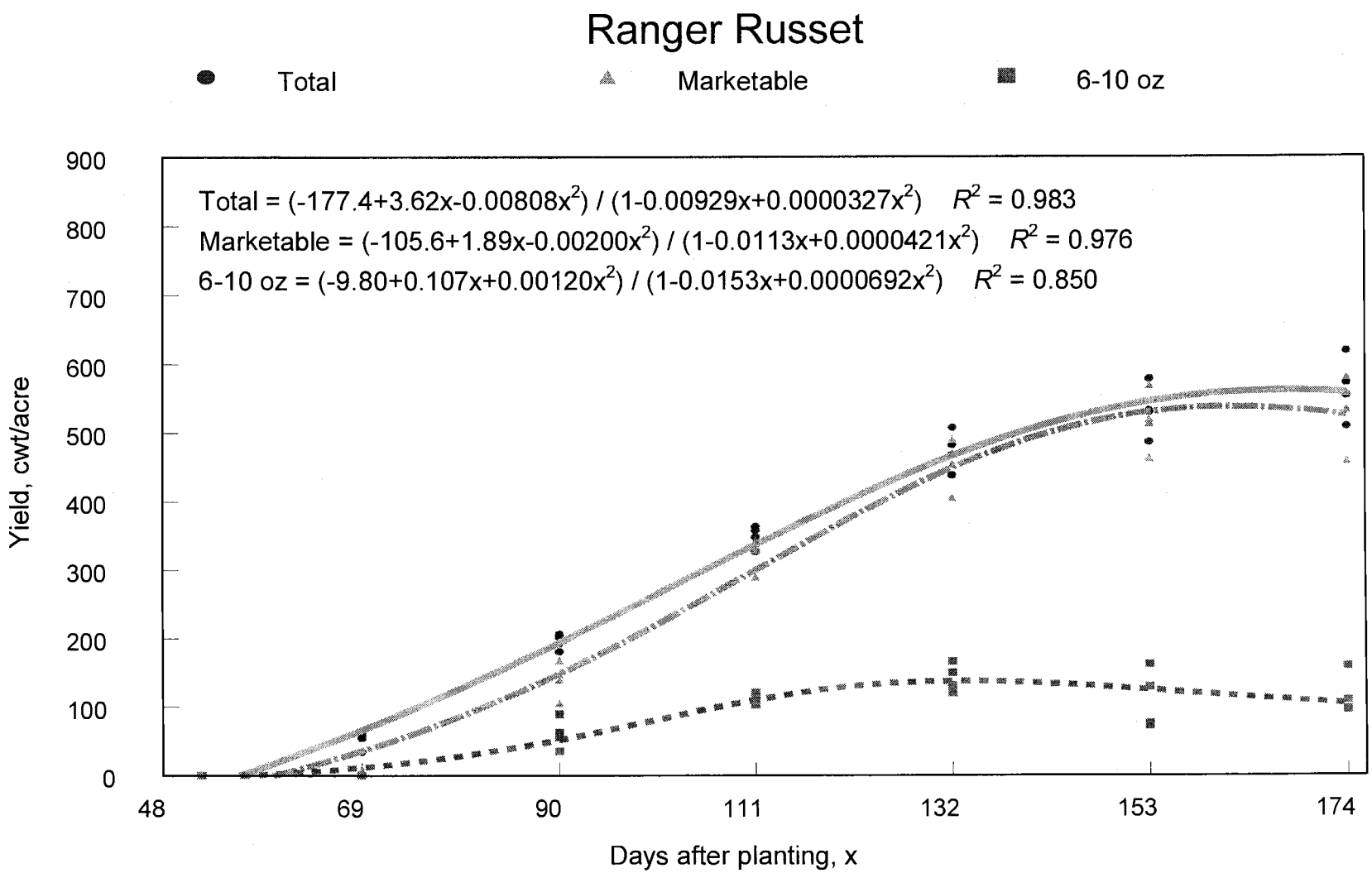

Figure 9. Tuber bulking over time for the cultivar Ranger Russet, Oregon State University Malheur Experiment Station, Ontario, OR, 2003.

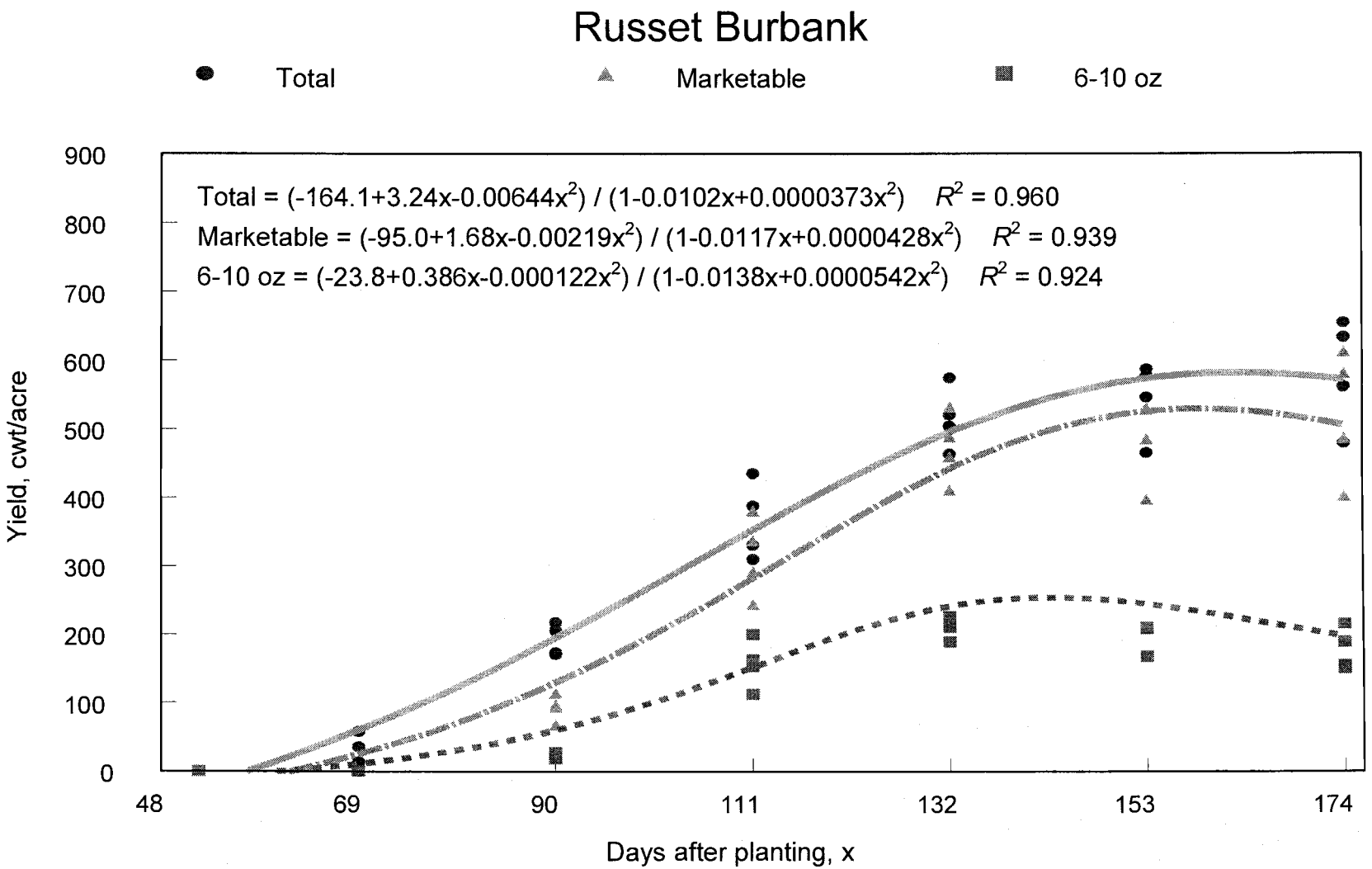

Figure 10. Tuber bulking over time for the cultivar Russet Burbank, Oregon State University Malheur Experiment Station, Ontario, OR, 2003.

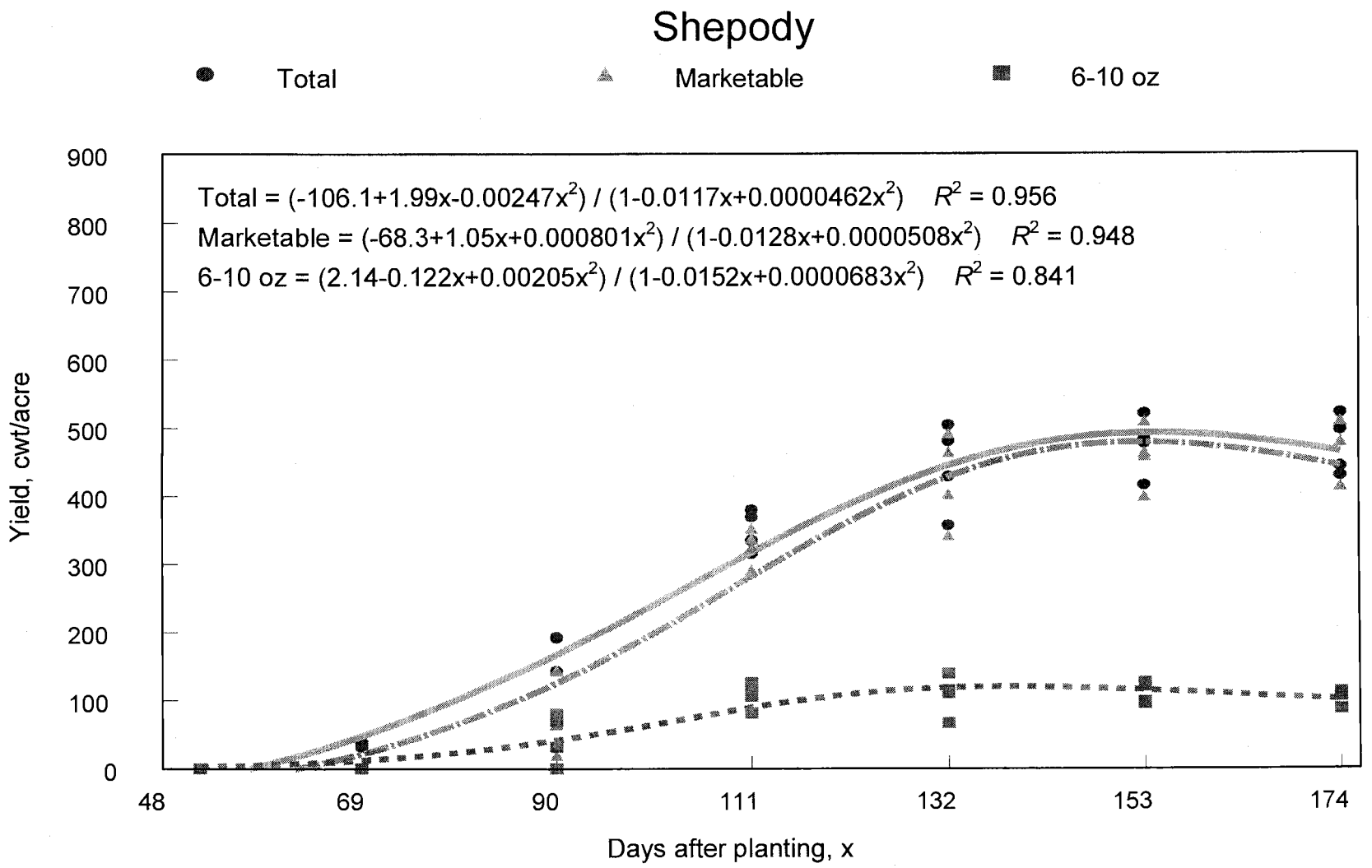

Figure 11. Tuber bulking over time for the cultivar Shepody, Oregon State University Malheur Experiment Station, Ontario, OR, 2003.

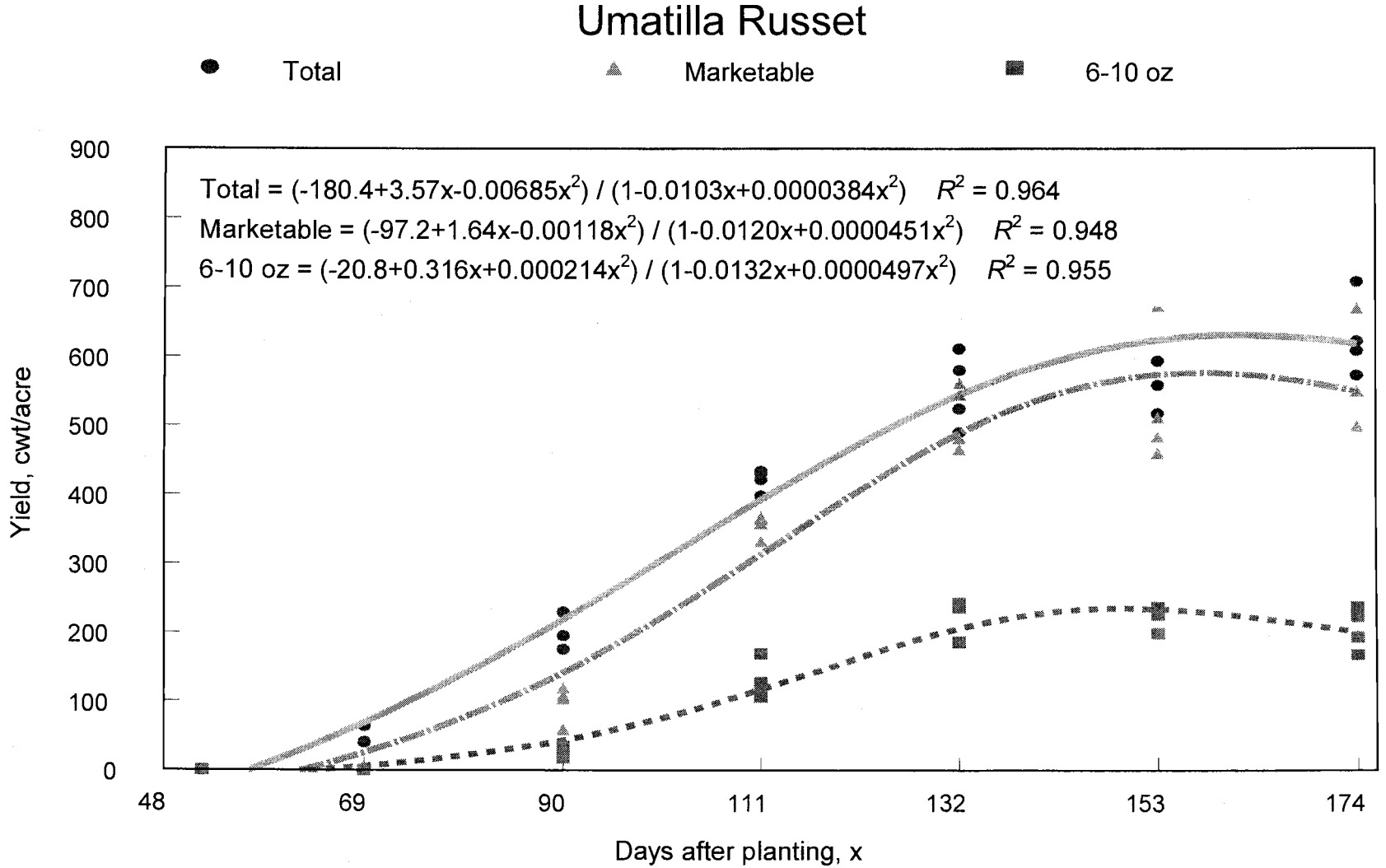

Figure 12. Tuber bulking over time for the cultivar Umatilla Russet, Oregon State University Malheur Experiment Station, Ontario, OR, 2003.

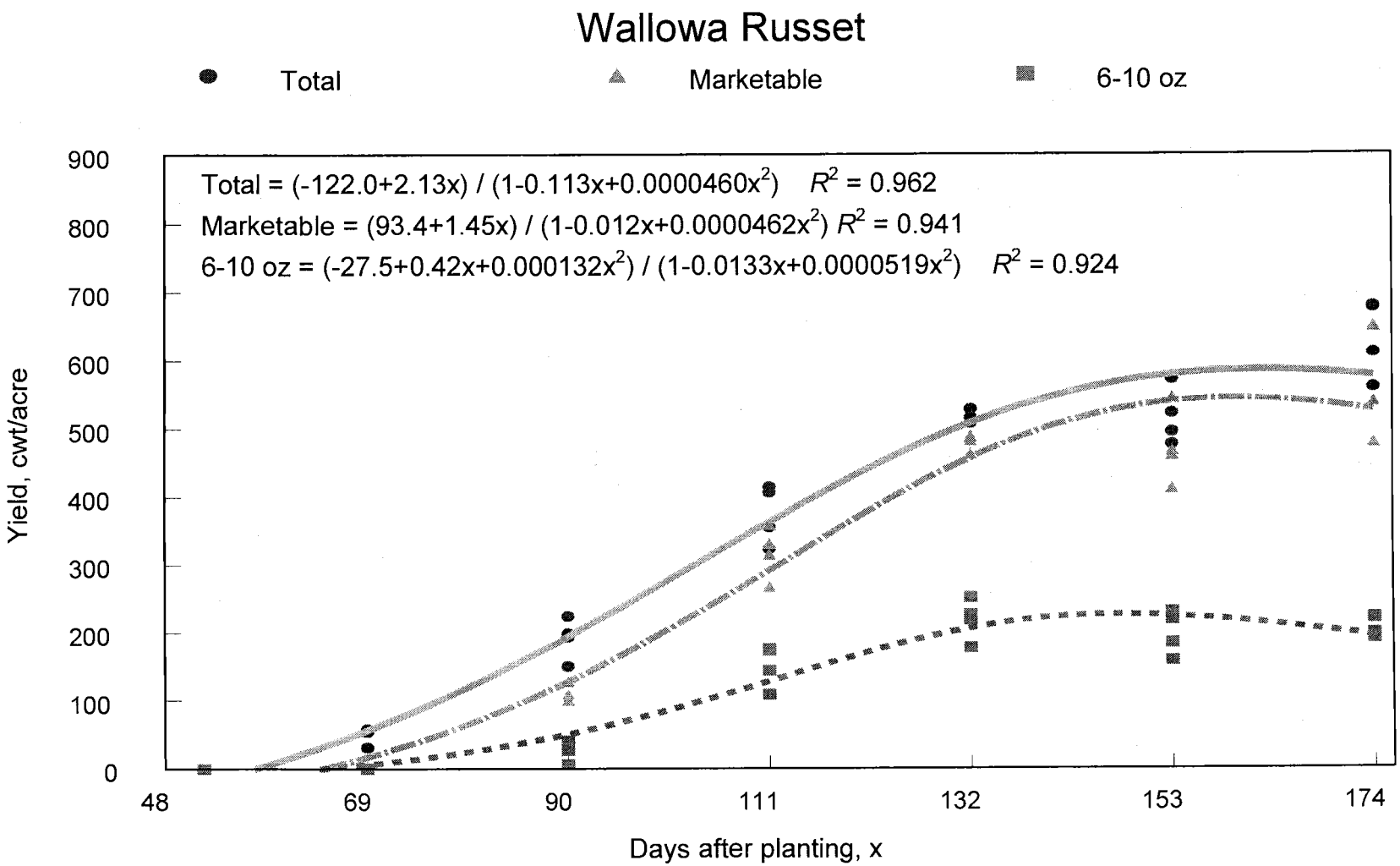

Figure 13. Tuber bulking over time for the cultivar Wallowa Russet, Oregon State University Malheur Experiment Station, Ontario, OR, 2003.

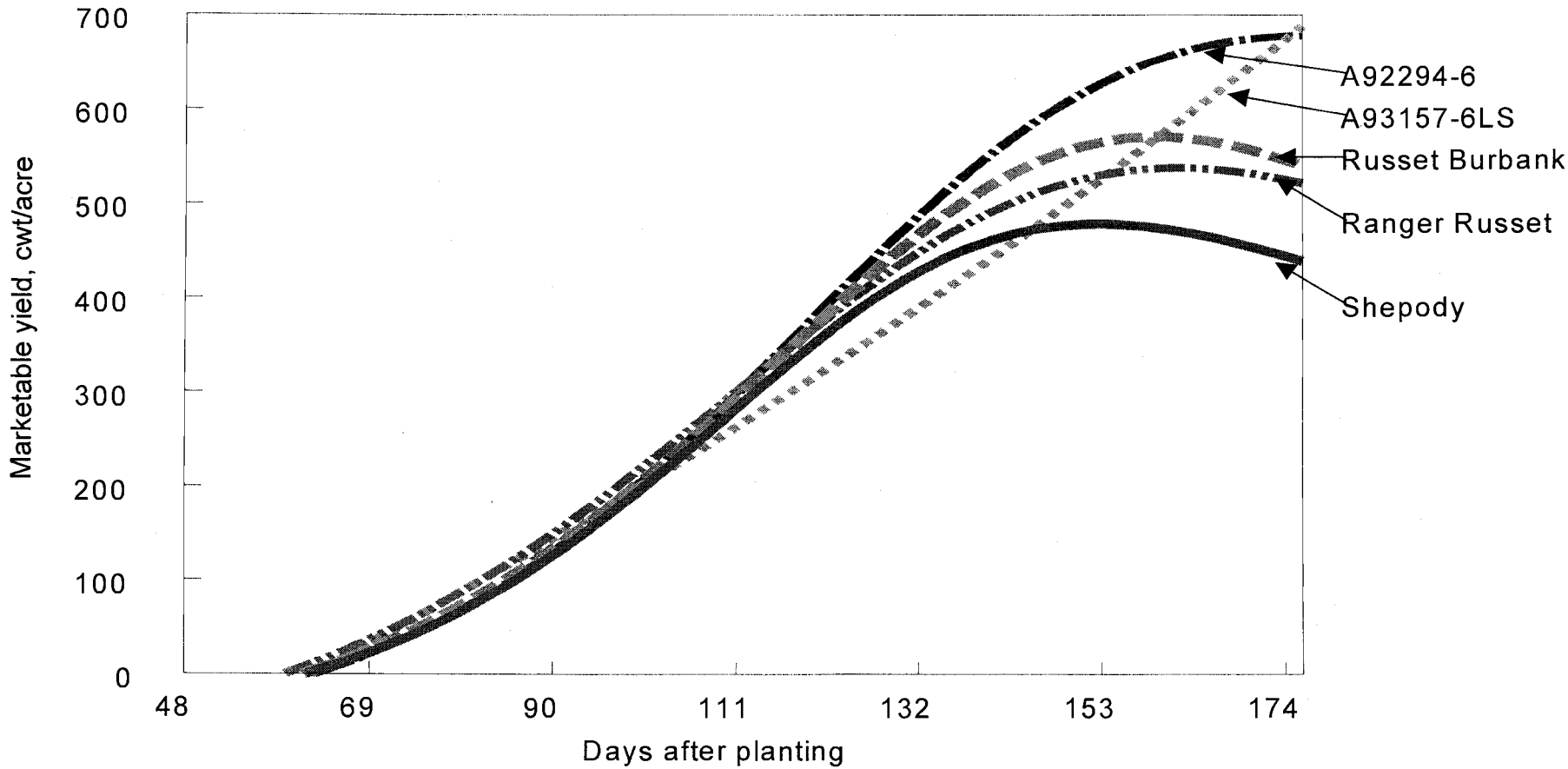

Figure 14. Marketable yield of A92294-6 and A93157-6LS over time compared to the marketable yield of Russet Burbank, Shepody, and Ranger Russet. Malheur Experiment Station, Oregon State University, Ontario, OR, 2003.